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NATIONAL EUTROPHICATION SURVEY

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REPORT

ON

TURKEY CREEK LAKE

FRANKLIN PARISH

LOUISIANA

EPA REGION VI

WORKING PAPER NO. 543

WITH THE COOPERATION OF THE

LOUISIANA WILD LIFE AND FISHERIES COMMISSION

AND THE

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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FRANKLIN PARISH, LOUISIANA

EPA REGION VI

By

National Eutrophication Survey

Water and Land Quality Branch
Monitoring Operations Division
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

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Corvallis Environmental Research Laboratory
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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Louisiana Wild Life and Fisheries Commission, Division of Water Pollution Control for professional involvement, to the Louisiana National Guard for conducting the tributary sampling phase of the Survey, and to those Louisiana wastewater treatment plant operators who provided effluent samples and flow data.

Robert A. Lafleur, Chief; J. Dale Givens, Assistant Chief; Lewis R. Still, Biologist; Louis Johnson, Biologist; Lee Caubarreaux, Biologist; Darrell Reed, Engineer; Dempsey Alford, Biologist; and Elwood Goodwin, Water Quality Control Technician, all of the Louisiana Wild Life and Fisheries Commission, Division of Water Pollution Control reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

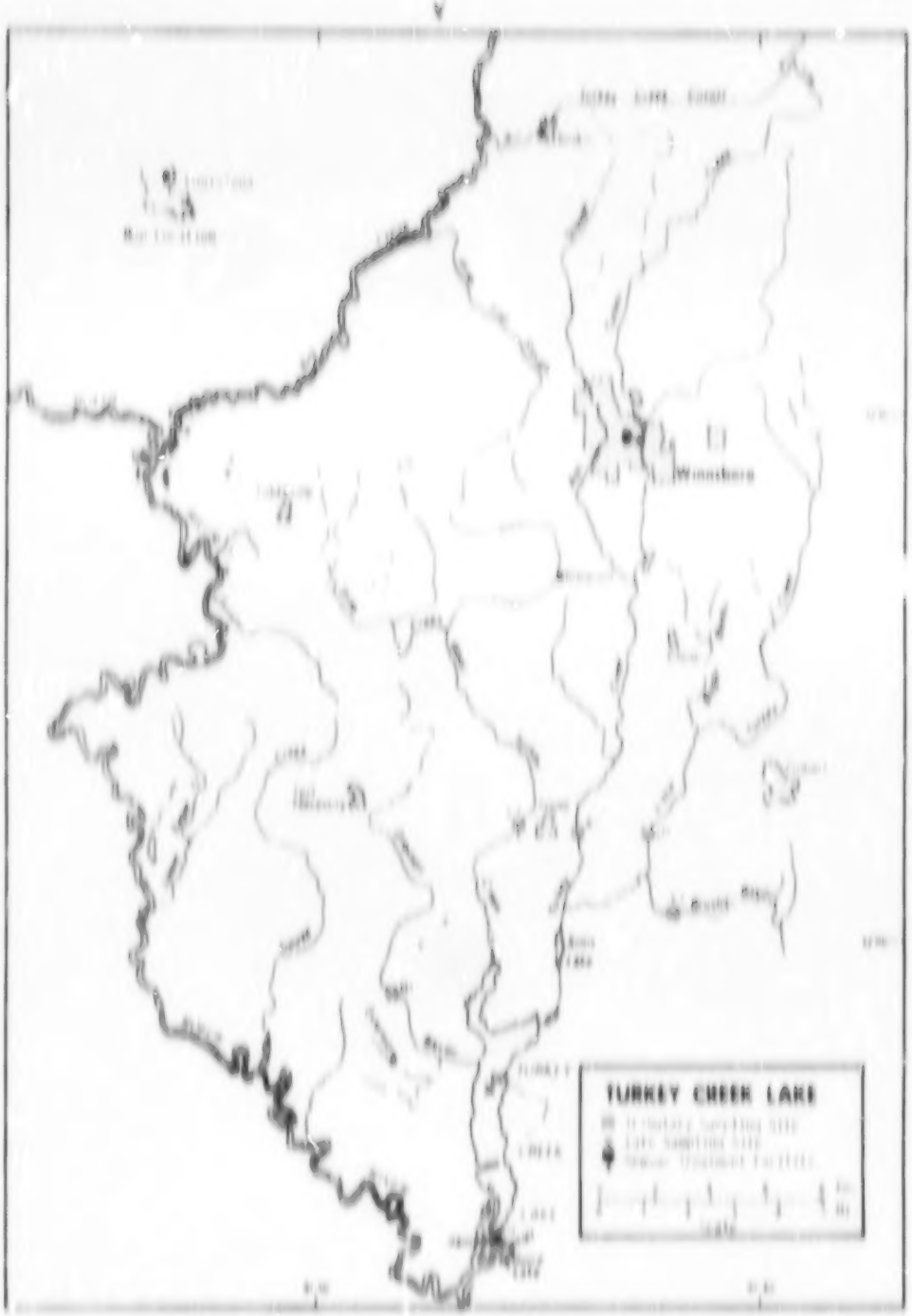
Major General O'Neil Daigle, Jr., the Adjutant General of Louisiana, and Project Officer Colonel Lawrence P. Dupre, who directed the volunteer efforts of the Louisiana National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF LOUISIANA

LAKE NAME	PARISH
Anacoco Lake	Vernon
Lake Bistineau	Bienville, Webster
Black Bayou	Caddo
Black Lake	Natchitoches and Red River
Bruin Lake	Tensas
Bundick Lake	Beauregard
Caddo Lake	Caddo (Menon and Harrison in Texas)
Cocodrie Lake	Concordia
Cocodrie Lake (Lower)	Rapides
Concordia Lake	Concordia
Cottle Lake	Rapides
Cross Lake	Caddo
D'Arbonne Lake	Union
False River Lake	Pointe Coupee
Indian Creek Reservoir	Rapides
Saline Lake	LaSalle
Turkey Creek Lake	Franklin
Lake Vernon	Vernon
Lake Verret	Assumption


TURKEY CREEK LAKE

REPORT ON TURKEY CREEK LAKE, LOUISIANA
STORET NO. 2215

I. CONCLUSIONS

A. Trophic Condition:*

Turkey Creek Lake is classified as eutrophic, i.e., nutrient rich and highly productive, based upon Survey data. Whether such nutrient enrichment is to be considered beneficial or deleterious is determined by its actual or potential impact upon designated beneficial water uses of each lake.

Of the 19 Louisiana lakes sampled, no lakes had higher median total phosphorus values, 3 had higher median inorganic nitrogen levels, and only 2 had higher median dissolved orthophosphorus values than Turkey Creek Lake. The mean Secchi disc visibility was 56 cm. Chlorophyll a values ranged from a low of 4.0 ug/l in the spring to a high of 55.4 ug/l in the summer, with a mean of 22.0 ug/l.

Survey limnologists observed floating algal mats and a surface scum during the fall sampling. The Louisiana Wild Life and Fisheries Commission (Louis Johnson, personal communication) reports that algae blooms and die-off in the lake have caused numerous fish kills in the past.

*See Appendix I.

B. Rate-Limiting Nutrient:

Algal assay results indicate that Turkey Creek Lake was limited by available nitrogen. Spikes with nitrogen alone or phosphorus and nitrogen simultaneously resulted in increases in assay yields. Addition of phosphorus alone did not stimulate a growth response. The ratios of available nitrogen to orthophosphorus (N/P) in sampled waters further suggest nitrogen limitation.

C. Nutrient Controllability:

1. Point sources -

Nutrient loading to Turkey Creek Lake was about five times the eutrophic level proposed by Vollenweider (1975) for a lake of such volume and detention time. The mean annual phosphorus load from point sources was estimated to be 8.3% and was totally contributed by the City of Winnsboro.

In general few lakes are nitrogen limited as a result of low nitrogen. Rather excessive phosphorus loads shift limitation to nitrogen or other factors. Regardless of the primary nutrient limitation suggested by either algal assay or nutrient ratios, the most feasible approach to nutrient control, if desirable, is through available phosphorus control technology and subsequent establishment of phosphorus limitation within the water body.

2. Nonpoint sources -

The mean annual phosphorus load from nonpoint sources was

41.7% of the total load. West Turkey Creek contributed 23.3%, and Little Turkey Creek contributed 27.6% of the total. Ungaged streams were estimated to have contributed 17.8%. Agricultural runoff is an additional source of nonpoint nutrient loading, although, no quantitative assessment of this loading to Turkey Creek Lake can be made at this time (Louis Johnson, personal communication).

The nonpoint phosphorus exports for Little Turkey Creek and Unnamed Stream (Section IV-D) were respectively 169 and 175 kg $P/km^2/yr$ during the sampling year. These rates are much higher than the export rates of the other Turkey Creek Lake tributaries. Both tributaries flow through developed land between the towns of Gilbert and Jigger, and are probably impacted by additional nutrient sources not recognized at this time. Further sampling is needed to determine an accurate nutrient budget for Turkey Creek Lake.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. Lake surface area and mean depth were provided by the State of Louisiana. Maximum depth was obtained from contour maps provided by the Louisiana Stream Control Commission. Tributary flow data were provided by the Louisiana District Office of the U.S. Geological Survey (USGS). Outlet drainage area includes the lake surface area. Mean hydraulic retention time was obtained by dividing the lake volume by the mean flow of the outlet. Precipitation values are estimated by methods as outlined in National Eutrophication Survey (NES) Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 12.64 km^2.
2. Mean depth: 2.0 meters.
3. Maximum depth: 6.1 meters.
4. Volume: 25,287 x 10^6 m^3.
5. Mean hydraulic retention time: 57 days.

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

Name	Drainage area(km^2)	Mean flow (m^3/sec)
A-2 Turkey Creek	160.6	1.82
B-1 Grayson Bayou	23.8	0.10
C-1 West Turkey Creek	92.7	1.04
D-1 Little Turkey Creek	77.2	0.86
E-1 Unnamed Stream	2.6	0.01
Minor tributaries and immediate drainage -	91.6	1.17
Totals	448.5	5.02
2. Outlet - A-1 Turkey Creek	461.0	5.17

C. Precipitation:

1. Year of sampling: 178.9 cm.
2. Mean annual: 131.9 cm.

III. LAKE WATER QUALITY SUMMARY

Turkey Creek Lake was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from a number of depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll *a* analysis and phytoplankton identification and enumeration. During the first and last visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 2.4 meters at Station 01 and 3.7 meters at Station 02. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll *a* determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/19/74	1. Flagellates	1,843
	2. Melosira	778
	3. Pennate diatom	115
	4. Cryptomonas	86
	5. Oscillatoria	86
	Other genera	377
	Total	3,285
05/30/74	1. Melosira	797
	2. Dactylococcopsis	644
	3. Oscillatoria	613
	4. Centric diatom	552
	5. Cryptomonas	430
	Other genera	2,296
	Total	5,332
11/11/74	1. Flagellates	738
	2. Melosira	601
	3. Stephanodiscus	547
	4. Cryptomonas	465
	5. Trachelomonas	465
	Other genera	1,717
	Total	4,615

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (ug/l)
03/19/74	01	4.0
	02	4.6
05/30/74	01	26.9
	02	55.4
11/11/74	01	25.6
	02	15.3

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. 03/19/74

Spike(mg/l)	Ortho P Conc.(mg/l)	Inorganic N Conc.(mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.105	0.121	3.7
0.05 P	0.155	0.121	4.7
0.05 P + 1.0 N	0.155	1.121	18.6
1.00 N	0.105	1.121	18.8

b. 11/11/74

Spike(mg/l)	Ortho P Conc.(mg/l)	Inorganic N Conc.(mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.021	0.040	1.9
0.05 P	0.071	0.040	1.7
0.05 P + 1.0 N	0.071	1.040	18.1
1.00 N	0.021	1.040	6.1

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential for primary productivity was high on Turkey Creek Lake during the spring and fall samplings. In both assays, additions of nitrogen or nitrogen and phosphorus simultaneously resulted in increased yields, indicating nitrogen limitation. Additions of phosphorus alone did not result in significant increases in yield.

The N/P ratios in the field were 2/1 in the spring, 10/1 in the summer, and 6/1 in the fall, also indicating the lake was nitrogen limited at those times (a mean N/P ratio of 14/1 or greater indicates phosphorus limitation).

It should be noted that significant chemical changes took place in Louisiana lake samples between collection and algal assay. The assay data should be considered in this context and until such differences are resolved, used with caution for any predictions of actual lake conditions. Such chemical changes are likely to alter the control yield as well as modifying the N/P ratio.

IV. NUTRIENT LOADINGS
(See Appendix B for data)

For the determination of nutrient loadings, the Louisiana National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of February, March, and April when two samples were collected. Sampling was begun in June 1974, and was completed in May 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Louisiana District Office of the USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of USGS) were estimated by using the mean annual nutrient loads, in $kg/km^2/yr$, in Grayson Bayou and West Turkey Creek at Stations B-1 and C-1, and multiplying the means by the ZZ area in km^2.

The operator of the Winnsboro wastewater treatment plant provided monthly effluent samples. Nutrient loads for that plant were calculated using an estimated (per capita) flow and the provided sample chemistries.

A. Waste Sources:

1. Known municipal -

Name	Population Served*	Treatment*	Mean Flow ($m^3/d \times 10^3$)	Receiving Water*
Winnsboro	5,610	Stabilization pond	2.123**	Turkey Creek Lake

2. Known industrial - None

*Treatment plant questionnaires.
**Estimated at 0.3785 m^3/capita/day.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Turkey Creek	8,620	18.2
B-1 Grayson Bayou	1,555	3.3
C-1 West Turkey Creek	11,015	23.3
D-1 Little Turkey Creek	13,015	27.6
E-1 Unnamed Stream	455	1.0
b. Minor tributaries and immediate drainage (nonpoint load) -	8,425	17.8
c. Known municipal STP's -		
Winnsboro	3,915	8.3
d. Septic tanks* -	5	<0.1
e. Known industrial - None		
f. Direct precipitation** -	220	0.5
Totals	47,225	100.0
2. Output - A-1 Turkey Creek	29,890	
3. Net annual P accumulation -	17,335	

*Estimate based on 25 lakeside residences.
**Estimated (see NES Workton Paper No. 175).

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Turkey Creek	62,045	25.0
B-1 Grayson Bayou	6,820	2.7
C-1 West Turkey Creek	52,240	21.1
D-1 Little Turkey Creek	63,640	25.7
E-1 Unnamed Stream	1,355	0.6
b. Minor tributaries and immediate drainage (nonpoint load) -	39,020	15.7
c. Known municipal STP's -		
Winnsboro	8,970	3.6
d. Septic tanks* -	265	0.1
e. Known industrial - None		
f. Direct precipitation** -	13,540	5.5
Totals	247,895	100.0
2. Output - A-1 Turkey Creek	202,615	
3. Net annual N accumulation -	45,280	

*Estimate based on 25 lakeside residences.
**Estimated (see NES Working Paper No. 175).

D. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Turkey Creek	54	300
Grayson Bayou	65	207
West Turkey Creek	119	564
Little Turkey Creek	169*	624
Unnamed Stream	175*	621

*The high background loading suggests contributions of unknown point sources upstream.

E. Yearly Loadings:

In the following table, the existing phosphorus annual loading is compared to the relationship proposed by Vollenweider (1975). Essentially, his "eutrophic" loading is that at which the receiving waters would become eutrophic or remain eutrophic; his "oligotruphic" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A "mesotrophic" loading would be considered one between "eutrophic" and "oligotrophic".

Note that Vollenweider's model may not apply to lakes with short hydraulic retention time; or in which light penetration is severely restricted by high concentrations of suspended solids in the surface waters.

	Total Yearly Phosphorus Loading ($g/m^2/yr$)
Estimated loading for Turkey Creek Lake	5.77
Vollenweider's "eutrophic" loading	0.69
Vollenweider's "oligotrophic" loading	0.34

V. LITERATURE REVIEWED

Johnson, Louis R. C. 1977. Personal Communication (Water Quality in Turkey Creek Lake). Louisiana Wild Life and Fisheries Commission, New Orleans, Louisiana.

U.S. Environmental Protection Agency. 1975. National Eutrophication Survey Methods 1973-1976. Working Paper No. 175. National Environmental Research Center, Las Vegas, Nevada, and Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

Vollenweider, R. A. 1975. Input-Output Models With Spe-tal Reference to the Phosphorus Loading Concept in Limnology. Schweiz. Z. Hydrol. 37:53-84.

VI. APPENDICES

APPENDIX A
CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B

TRIBUTARY FLOW DATA

[illegible]

APPENDIX C

PHYSICAL AND CHEMICAL DATA

APPENDIX D

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

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APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1974

STATE OF LOUISIANA

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